EXPANSION OF DEPARTMENT OF DEFENSE ENTERPRISE REQUIREMENTS AND ACQUISITION MODEL

GRADUATE RESEARCH PROJECT

Jonathon A. Montgomery
Major, USAF

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DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY

AIR FORCE INSTITUTE OF TECHNOLOGY

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Jonathon A. Montgomery, B.S. Aerospace Eng., M.B.A, Major USAF

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UPDATE TO ENTERPRISE REQUIREMENTS AND ACQUISITION MODEL

Jonathon A. Montgomery, B.S. Aerospace Eng., M.B.A, Major USAF

Approved:

_____	_____
Lt Col Joseph R. Wirthlin, PhD. (Chairman)	Date
_____	_____
Dr. John M. Colombi (Member)	Date

Abstract

Air Force senior leadership has continued to emphasize the need for progress on improving cost and schedule estimates for military acquisition programs. The Enterprise Requirements and Acquisition Model (ERAM) as modified by Leach and Searle is a quantitative discrete-event process simulation model accounting for activities from early capability analysis through system fielding of ACAT I space acquisition programs. This research seeks to modify the existing model by including ACAT II/III programs along with modeling the Rapid Acquisition process for space programs using the same methodology and techniques. The model begins with identification of a desired space capability early in the Joint Capabilities and Integration Development System (JCIDS) process through system development at Milestone-C (MS-C) of the acquisition system resulting in a probabilistic schedule distribution for a given concept. The research focused on identifying activities and assigning duration distributions and probabilities based upon past programs at each decision point. Data was collected through analysis of applicable policy, instructions, and journal articles as well as interviews with subject matter experts (SME) from the Air Staff, AFSPC and the Space and Missile Systems Center (SMC). ERAM has been utilized at SMC's space Concept Design Center (CDC) providing program managers insight into program duration estimations and probabilities of program success for concepts based on historical comparisons. Defense Acquisition University has also found interest in ERAM to be used as a training tool for personnel to better understand required procedures needed to acquire a space capability on schedule and within budget.

Acknowledgements

I would like to sincerely thank the staff in the Department of Systems and Engineering Management for their continued support and feedback during this research. Lt Col Wirthlin provided continual leadership and advice as I tackled this challenge. Thank you to the SMC/Development Planning Branch and Aerospace Corporation for their sponsorship and tremendous working relationship. Most importantly, I want to thank my wife for her continuous support and tireless bravery during our year apart while I was studying at AFIT.

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I. Introduction

The United States military has enjoyed unprecedented strength in dealing with its nations enemies over the last thirty years. After the Vietnam War, the United States rebuilt its forces to be unmatched by any country on the planet. Many even argue that this military strength significantly contributed to the end of the Cold War, without any major conflict actually taking place (Stein, 1994). Following the end of the Cold War, the military was drawn down significantly but also benefitted immensely by upgrades in technology that made it more lethal with a smaller force. Computer technology, GPS, and stealth are just a few examples that allowed U.S. forces to soundly defeat Iraq in 1991 and then invade and occupy Afghanistan and Iraq in 2001 and 2003. The Afghanistan and second Iraq conflicts did not go as smoothly as the first Iraq war. Instead, both dragged on for many years, forcing the military to reshape itself through the buildup of personnel and new equipment.

The United States pulled the last of its forces out of Iraq in 2011 and signed an agreement with Afghanistan in 2012 to have U.S forces leave by 2014 (Fox News, 2012). Along with these wars, the U.S. economy has been sputtering since 2008 causing the U.S. government to spend large amounts of money to prop up businesses and, in some cases, entire industries. These large expenses, along with large recurring benefit expenditures on programs such as Medicare, have forced the U.S. government to relook at spending across the board. Drawing down defense spending is not abnormal

following conflicts. Defense spending has decreased over 29% each time a conflict has ended since the Korean War.

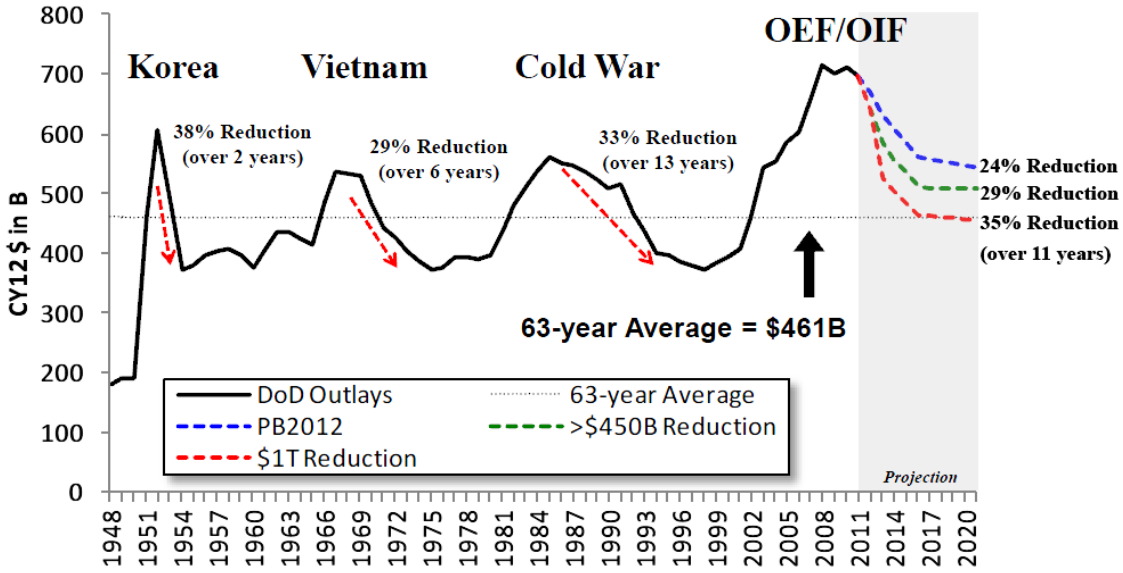


Figure 1: Defense Spending

(Office of the Under Secretary of Defense/CFO, February 2011)

"I've proposed a new defense strategy that ensures we maintain the finest military in the world, while saving nearly half a trillion dollars in our budget" (Obama, 2012). President Obama's statement in early 2012 was meant to show that the times of large military budgets are over. While politicians battle over this reduction, every one of the 26 people interviewed for this research recognize that that a budget cut is a foregone conclusion. The only thing they don't know is how large it will be. The DoD has submitted a Fiscal Year(FY) 2013 budget for approval that cuts $31.8B from FY 2012 spending (Office of the Under Secretary of Defense/CFO, 2012).

The DoD has a very unique mission, unlike any other organization in the world. It is charged with deterring war, protecting the interests of the United States and

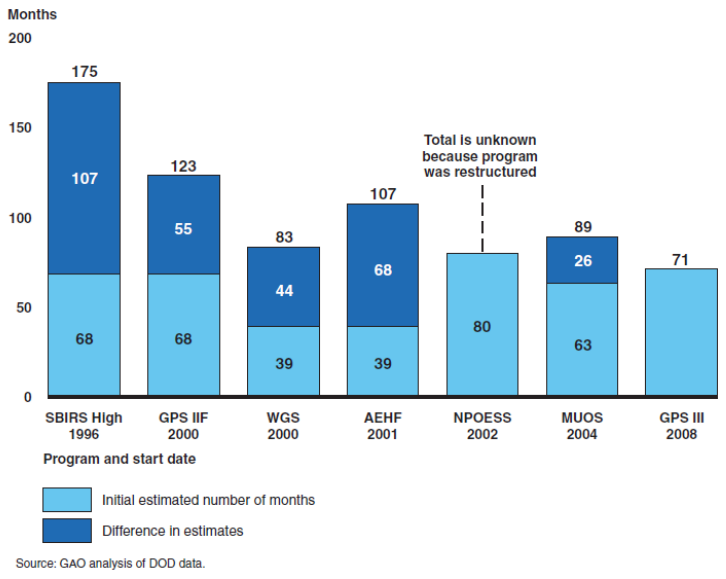
defeating aggression anywhere in the world. Since it is charged with such a unique mission, the equipment that is required is usually very unique as well. In order to develop and field this equipment, the DoD has set up acquisition organizations that focus on meeting the needs of the warfighters while complying with a multitude of rules and regulations prescribed by lawmakers and DoD policy makers. These laws and policies are the result of the modern day lessons learned, process evolution and lambasting of the acquisition process by a multitude of sources. When an evaluation of the acqusition process starts off with "DOD is facing a cascading number of problems in managing its acquisitions", major changes need to take place (United Stated Government Accountability Office, 2005).

In order to reverse the negative direction that acquisition programs had been heading, the U.S. government enacted numerous new regulations on top of the ones that already existed. The most far-reaching was the Weapons Systems Acquisition Reform Act (WSARA) of 2009 which attempted to counter "$295 billion in waste and cost overruns in defense contracts" (Alexander, 2009). Despite these new rules and regulations, in 2012 many defense acquisition programs are still over budget and behind schedule. Continual work to improve the process goes on from within the system as program managers attempt to deliver the capability requested by warfighters while staying within the bounds of the budget and schedule they were given.

"We're running out of money so we must begin to think" has been attributed to Ernest Rutherford, the famous scientist, when he was asked about the looming budget crisis in his native New Zealand in 1927 (Luce, 2012). Director of National Intelligence

James Clapper has recently started reiterating that line in speeches around Washington D.C. as he prepares the intelligence community for the looming budget cuts (Kelly, 2012). He recognizes that managers must work smarter to achieve their goals in this new enviornment of government spending austerity. As they attempt to achieve more with less, tools that facilitate their success are necessary.

This research augments a tool that is available to managers in space acquistion programs. Space programs have notoriously been over budget and schedule and continue to follow that precedent. The GAO chart below shows that the schedules for seven major space programs nearly doubled from their estimates(United States Government Accountability Office, 2012). While it is unclear if this is because of poor estimates or due to programmatic problems, it is obvious that a better understanding of space program schedules is needed.



Legend: SBIRS = Space Based Infrared System High; GPS = Global Positioning System; WGS = Wideband Global SATCOM; AEHF = Advanced Extremely High Frequency; NPOESS = National Polar-orbiting Operational Environmental Satellite System; MUOS = Mobile User Objective System.

Figure 2: Increase in Space Program Schedules

(United States Government Accountability Office, 2011)

Enterprise Requirements and Acquisition Model (ERAM)

A doctoral dissertation, "Identifying Enterprise Leverage Points in Defense Acquisition Program Performance", was published in September 2009 aiming to characterize the system of acquiring large, complex, socio-technological systems for the DoD (Wirthlin, 2009). It was an in-depth analysis of the discrete events and products required for a typical Air Force acquisition program throughout the lifecycle, with emphasis placed on events prior to Milestone-C (MS-C). Data about the events and products was gathered through analysis of existing policy and guidance as well as many interviews with defense acquisition professionals. The data collected was modeled and programmed into the Arena software modeling tool. This resulted in the first-ever discrete-event simulation of the entire defense acquisition model, although abstracted at an elevated level.

In the Fall of 2010, the SMC, Development Planning branch (SMC/XR) sponsored further research and analysis on Wirthlin's work, focusing specifically on early space requirements and acquisition activities for ACAT I programs. This resulted in a thesis focusing on bringing the model up to date, transitioning to a new software program and enhancing it to specifically focus on ACAT I space programs. Leach and Searle's work implemented Wirthlin's model and methodology while transitioning to the Extendsim software.

Wirthlin attempted to model a complicated set of processes that is run by a virtual army for the DoD. Leach and Searle designated Wirthlin's work as ERAM 1.0. As this research is an expansion of their work, this research will continue with this

nomenclature. ERAM 1.0 simulated various activities and events using probabilities for decision event outcomes and timeline distributions to determine likely overall program timelines as well as probabilities of successful program execution up to MS-C. The output is reflected by a probabilistic determination of likely program duration through approval of MS-C using Monte Carlo simulation techniques. ERAM 1.0 modeled a capability concept or idea entering the Major Command (MAJCOM) requirements process and simulated its path to termination. Additional implementation included decision points throughout the process flow to include determination of a successful design review, rework, funding checks and other events. The activities for discrete events incorporated triangular distributions for elapsed times. For example, timelines associated with affordability assessments, preparing for reviews, writing documents, all had probability distributions with a best case, worst case and most likely number of days, with the data elicited from various sources. These sequences of events with timeline probabilities and decision points as executed through the simulation delivered results enabling further analysis for decision-making. Accordingly, with additional refinement and enhancements this model has the potential to be used as a valuable data source for decision makers in forecasting a program's development and delivery schedules and life cycle costs (Wirthlin, 2009).

Leach and Searle designated their work ERAM 2.1 since it was a major modification to Wirthlin's work. They completed ERAM 2.1 in June 2011 and it was subsequently accepted by SMC/XR for use in the SMC Concept Design Center (CDC). The CDC is located in the basement of the Charles C. Lauritsen Library at the

headquarters of The Aerospace Corporation in El Segundo, CA. The Aerospace Corporation is a federally funded research and development center (FFRDC). [1] As the FFRDC for national-security space, Aerospace supports long-term planning and the immediate needs of our nation's military and reconnaissance space programs (Aerospace Corp).

The CDC is a facility that enables a cross-functional design and engineering team to work in an integrated manner. The facility consists of banks of networked computers, large displays all built around a centralized workspace. It can be seen in Figure 3. The facility is used when a requirement for a new space system wants to be explored by a SMC customer. A team of subject matter experts (SME) in spacecraft disciplines such as structures, propulsion and sensors is assembled from the Aerospace staff to staff the CDC. In addition, SMEs in systems engineering, budgeting, and acquistion are brought in as part of the team. This team assembles in the CDC with customer representatives to create a conceptual design including a budget and schedule over the course of 2-3 days. This work allows decision makers to understand the feasibility of satisfying a requirment as well as providing a rough order of magnitude estimate for completing the program.

[1] FFRDCs are unique independent nonprofit entities sponsored and funded by the U.S. government to meet specific long-term technical needs that cannot be met by any other single organization. The Aerospace Corporation is sponsored by the United States Air Force, and provides objective technical analyses and assessments for space programs that serve the national interest.

Figure 3: Concept Design Center

SMC/XR sponsored the research on ERAM to be used as the tool for the Acquistion SMEs in the CDC. Prior to this work, the Acquistion SME was the only member of the team that did not have a tool and instead was basing their work solely on their personal experience. While the Aerospace SMEs are considered some of the preeminent experts in their fields, SMC recognized that ERAM could be expanded and modified to provide even better acquistion program estimates for their customers. The acquistion portfolio of SMC is actually currently comprised of 50% ACAT I programs and 50% ACAT II/III and other programs.

In the fall of 2011, SMC/XR once again sponsored further research and analysis on ERAM 2.1, focusing specifically on expanding the model to include other types of acquisition programs. They specifically wanted to diversify the model so that it would include ACAT II, ACAT III and rapid acquisition programs. These programs have different rules and, in some cases, processes that govern how they are managed and executed.

The goals of SMC/XR to update and expand the work of Leach and Searle are covered by the three research objectives listed below.

1. Review and update ERAM 2.1 to ERAM 2.2 for space ACAT II/III programs.
2. Review and update ERAM 2.1 to ERAM 2.2 for space rapid acquisition programs.
3. Identify additional research requirements for future versions of ERAM

II. Literature Review and Background Information

This topic required the review of more than 60 policy documents, official instructions, guidance, journal articles, government reports and briefings. As this research follows closely on the heels of the Leach and Searle 2011 paper "Department of Defense Enterprise Requirements and Acquisition Model," it served as the primary baseline for this paper. Their research was the first attempt at modeling the space acquisition system. All studies prior to their work such as GAO-11-590T and GAO 08-552T point out the problems in the space acquisition process and offer solutions but don't attempt to model it.

Due to this fact, the core documents that were reviewed to expand ERAM were the same as the ones used by Leach and Searle. More detail on them can be found in Leach and Searle's work, listed in Appendix III. Table 2 represents the documents that played the greatest importance to this effort.

Table 1: Primary Documents

	Resource
1)	Leach, David A. and Searle, Chad T., *Department of Defense Enterprise Requirements and Acquisition Model*
2)	Strategic Command Instruction 534-19 *Operationally Responsive Space*
3)	Department of Defense Instruction 5000.02 *Operation of the Defense Acquisition System*
4)	Chairman of the Joint Chiefs of Staff Instruction 3170.01H *Joint Capabilities Integration and Development System*

5)	Air Force Instruction 63-114 *Quick Reaction Capability Process*
6)	Title 10, United States Code *Armed Forces*

1. Leach, David A. and Searle, Chad T., *Department of Defense Enterprise Requirements and Acquisition Model*

Leach and Searle's work served as the beginning point for this research, as it is an expansion of the model that they built in collaboration with SMC/Aerospace Corp. Their work begins with the identification of a desired space capability early in the JCIDS process through system development at Milestone-C of the acquisition system resulting in a probabilistic schedule distribution for a given concept. Their version of ERAM provided a comprehensive early schedule estimate based upon existing government policy and instructions.

They explored all available space acquisition policy, regulations, statutes, existing practices and expertise from SMEs to convert Wirthlin's original Air Force-wide ERAM model into a space acquisition specific model that could be applied to SMC's early systems engineering efforts at the Concept Design Center. In addition, through their research they were able to identify key challenges to space capability development and propose solution to each.

Table 2: Key Challenges to Space Acquisition

Challenge	Solution
Inadequate early systems engineering	Implement early systems engineering prior to MDD and MS-A
Failure of the government to assess technology maturity	Improve technical knowledge base and establish improved evaluation methods
Improper distribution of personnel between HQ and program offices	Reallocate personnel to program offices and training centers for them
Lack of process discipline	Centralize processes to ensure processes are standardized
Poor 6X Training and evaluation program	AF expand training for acquisition professionals beyond DAU requirements
Process disconnects between MAJCOM and AFRL	Technology requirements and availability need to be better passed back and forth

2. Strategic Command Instruction 534-19 *Operationally Responsive Space*

While no one document establishes the operationally responsive space process (ORS), this instruction provides the best information. It establishes the responsibilities of the organizations within the process, explains the steps within the process and also lays out the goals of the ORS program. The interesting point about this instruction is that it is written from the perspective of USSTRATCOM, which never has been in the chain of command of the ORS Office. Instead, their main role is to supply requirements for consideration to the DoD Executive Agent for Space. Therefore, while this instruction seems directive to all parties, it appears the authors took liberties with their authority and therefore it needs to taken with a grain of salt.

3. Department of Defense Instruction 5000.02 *Operation of the Defense Acquisition System*

DoD 5000.02 details the procedures to operate the acquisition system. It has been modified numerous times with policy letters and addendums but still serves as the baseline document for acquisition officials. For this research, it was especially important because it details the difference between ACAT levels and the processes that must be followed for each.

4. Chairman of the Joint Chiefs of Staff Instruction 3170.01H *Joint Capabilities Integration and Development System*

CJCSI 3170.01H was published in early 2012 to bring together various documents concerning the JCIDS process. For this research, it was important because it details the requirements for a request to be approved as an urgent operational need and the joint process for fulfilling urgent operational needs with rapid acquisition programs. It also specifies what steps may be skipped in the JCIDS process to help expedite rapid acquisitions.

5. Air Force Instruction 63-114 *Quick Reaction Capability Process*

AFI 63-114 is the authoritative document on how Air Force acquisition units are supposed to respond to urgent operational needs. It specifies the steps that were used as the starting point for modeling the Air Force rapid space acquisition process in ERAM

2.2. While it is supposed to be authoritative, not all Air Force units utilize this document but instead have authority to operate using other processes.

6. Title 10, United States Code *Armed Forces*

Title 10, United States Code is the listing of federal statutes that specify the operation of the United States Armed Forces. It lays out the legal requirements that DoD and service regulations must comply with when operating the military acquisition system. It was important to this research because it specifies approval authorities, reporting requirements and cost assessment responsibilities for programs. This affected the ERAM 2.2 model because some requirements are different for certain types of programs.

Acquisition Categories

Acquisition programs are categorized based on their overall cost and interest by law/policy makers and acquisition approval authorities (USD(AT&L), 2008). Table 1 lays out the basic criteria for each category as specified in DoDI 5000.02. In most cases, the total cost of the program drives it to a certain category. Rapid programs can fit into any of the categories but normally are ACAT III or not Programs of Record. In addition to the three categories, there are many acquisition programs that never become a Program of Record. A Program of Record is recorded in the Future Years Defense Program(FYDP), essentially the listing and budgeting of all approved acquisition programs. If an acquisition program is not a Program of Record, then it is funded from the services operational budget and therefore not given an acquisition category.

Table 3: Acquisition Categories

ACAT I	• Designated by the USD(AT&L) as Major Defense Acquistion Program • Dollar value: estimated by the USD(AT&L) to require an eventual total expenditure for research, development, test and evaluation (RDT&E) of more than $365 million in fiscal year (FY) 2000 constant dollars or, for procurement, of more than $2.190 billion in FY 2000 constant dollars • MDA designation as special interest
ACAT II	• Does not meet criteria for ACAT I • Dollar value: estimated by the DoD Component Head to require an eventual total expenditure for RDT&E of more than $140 million in FY 2000 constant dollars, or for procurement of more than $660 million in FY 2000 constant dollars • USD(AT&L) designation
ACAT III	Does not meet the criteria for ACAT II or above
Non-Program of Record	• Program not listed in FYDP

DoDI 5000.02 lays out the baseline acquisition processes that must be followed for the different different ACAT levels. ACAT I programs have the most stringent process while ACAT III have the least stringent. These processes are laid out as the minimum actions that must be taken for each program but they do not specify the details. Each service, and in most most cases the individual product center, details the specific steps that must be followed to be in compliance with the statutory, regulatory and policy laws and regulations.

While this is never overtly stated in DoDI 5000.02, acquistion classification and processes are essentially based on the level of risk of the program. This is obvious in the criteria for classification, the cost of the program or risk assessment by DoD leaders. In an effort to avoid risks, policy makers have chosen to implement more stringent controls for the more risky programs. A good example of this is the Milestone Decision Authority for ACAT I programs is the Undersecretary of Defense for Acquisition,

Technology and Logistics. Normally a service designee (usually a 3-star general) is the Milestone Decision Authority for ACAT II//III programs. As one program manager succinctly stated in an interview, “large programs are essentially more risky and therefore too big to fail. They get lots of oversight because either the benefit is so great or the cost is too big to swallow.”

ERAM 2.0 application and validation

In February/March 2012, SMC/XR collaborated with former employees of the Transformational Satellite Communications System (TSAT) program to evaluate the ability of ERAM to predict schedules. The TSAT program was a new satellite program intended to yield huge increases in secure communications bandwidth to U.S military forces. It was cancelled in 2009 in an effort to reduce defense spending (Brinton, 2009).

SMC/XR evaluated ERAM in a three step process. First, they ran the program themselves based on data they were able to gather. They then consulted with two former members of the program office to gain a better understanding of the program. After the consultation, they changed their inputs in ERAM based on the new data they acquired. During the first run with no input from the former TSAT program employees, ERAM estimated that the time to pass Milestone B would have a mean of approximately 150 months . The actual program was scheduled to pass Milestone B at 130 months. (Figure 4) Since they had only some information on the program, they utilized the Decision Cube, which varies parameters of the simulation such as technology readiness. For more information on the Decision Cube, see Leach and Searle’s work.

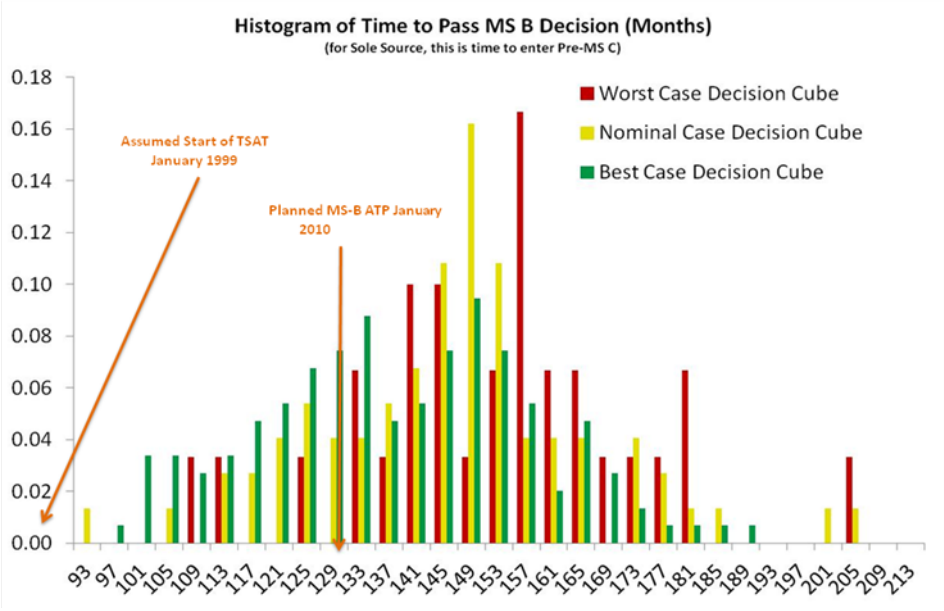


Figure 4: Time to Pass MS-B (No SME input)

Following their consultation with the former TSAT program employees, SMC/XR then reran ERAM based on the new input from the TSAT program. This resulted in a much better approximation for the amount of time to pass Milestone B. (Figure 5) ERAM predicted a mean of approxamitely 128 months which was signifigantly closer to the real TSAT schedule.

While this work lends some credibility to ERAM, one trial is not enough to validate the software. SMC/XR would like to continue to work with other programs to continue the validation but has had little success in getting cooperation. In general, program managers politely decline because they need their time to focus on their current program. Most likely, ERAM validation will take place as new acquistion programs pass through the CDC and then their actual results are compared to the predictions made by ERAM at their initiation.

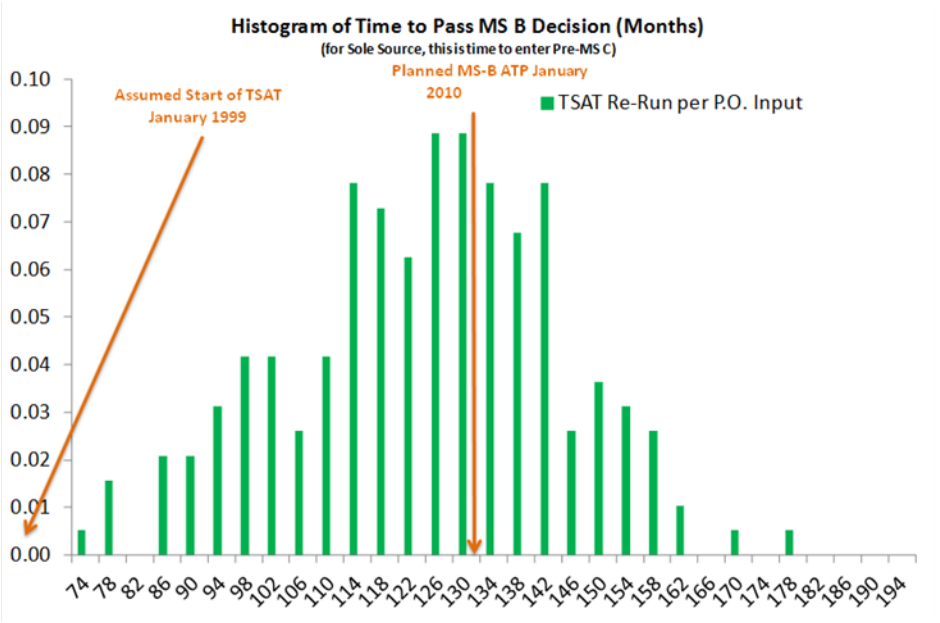


Figure 5: Time to Pass MS-B (With SME input)

Despite the fact that this evaluation of ERAM only looked at one program, SMC/XR and Aerospace were able to draw some conclusions about the application of ERAM. They called this group of conclusions "Every Program has a Story" because it became obvious, after looking at TSAT, that each acquistion program is unique. The bottom line that they learned from this evaluation was that ERAM needs to be more flexible in describing a "program's story" (Broder, 2012).

1. *"Real World" factors (outside the Air Force) had a great deal of impact on determining the programs start and demise*
2. *TSAT (and many programs) can be very dynamic so that model inputs that are accurate at the start can change year over year*
3. *The acquisition process, as depicted on the DAU Wall Chart, does not represent TSAT's (or many program's) actual path*

4. *Oral histories, as much as any collection of briefing charts, help describe the important underlying issues in acquisition*

The conclusions that SMC/XR drew support the motivation that has driven ERAM from the very beginning. The acquisition world is complex and not always representative of the documented processes. This research strived to expand and modify the model so that it is more representative of the "real world".

III. Methodology

This research was conducted utilizing qualitative social science and quantitative evaluation with the goal of modifying and expanding an existing quantitative discrete event simulation model of space acquisition program timelines to be utilized by SMC as a decision support tool during early concept analysis. As this is an expansion of the work conducted by Leach and Searle, it utilizes the same methodology as their research but focused on different organizations and data sets.

Research Scope

The focus of this research is to analyze and model the discrete events for Air Force ACAT II/III space programs from capability gap analysis through MS-C of the acquisition system. Additionally, rapid space acquisition programs were analyzed and modeled. Since these programs are run according to significantly different processes than normal acquisition programs, this research focused from requirement submission all the way to initial fielding of a capability. Focusing on the front end of ERAM limited the literature reviews and key personnel interviews to OSD, Acquisition, Technology & Logistics (OSD/AT&L), Secretary of the Air Force, Acquisitions (SAF/AQ), AFSPC, SMC, the Aerospace Corporation and government support contractors. Due to the fact that AFSPC maintains the cyber and information technology (IT) domain within their portfolio, some of the interviews related to these areas but the modeling remained focused on space acquisition since SMC was not interested in these topics.

As in ERAM 2.0, the PPB&E and Test and Evaluation (T&E) processes were not expanded beyond what was previously developed in ERAM 1.0. PPB&E is the calendar driven funding process; the detailed formal budgeting process will be a topic left to future research to increase the fidelity of ERAM. Certain elements in the model have incorporated checks for available funding, and above-threshold cost increases. However, it does not identify the specific activities and decision points as well as their duration distributions and probabilities, respectively. Uncertainty events which occur in the model may have ties to budget directives and decisions and will be based on out-of-cycle budget cut drills and other events gleaned from ERAM 1.0

Also, analysis of the T&E activities identified in ERAM 1.0 was not included in the scope of this research for ACAT II/III programs. Since rapid program obviously take place very quickly, T&E efforts were able to be studied at a high level and this is included in the updated model. Since it is such a important and time-intensive activity in most program, this is a prime topic for additional research, e.g. identify, document and update ERAM with the differences between aerospace and space ACAT I/II/III T&E activities.

Research Objectives

At the beginning of the research effort, the research objectives from Leach and Searle's work were revised and adjusted to meet the new goals of this iteration. The following objectives were identified and agreed upon by both the customer (SMC/XR) as well as the research team (AFIT/ENV).

1. Review and update ERAM 2.1 to ERAM 2.2 for space ACAT II/III programs.

2. Review and update ERAM 2.1 to ERAM 2.2 for space rapid acquisition programs.
3. Identify additional research requirements for future versions of ERAM

Process

Due to the fact that this research effort was an expansion and modification of the work completed by Leach and Searle, their approach was analyzed for applicability and adopted with some minor modifications.

1. Background Information Collection and Review – Review previous research, policy, instructions, guides
2. ERAM 2.1 Analysis – Familiarization with current model
3. Conduct Interviews – Identify subject matter experts and conduct interviews on experience relevant to ERAM 2.2 research objectives
4. Model Processes and Implement updates to develop ERAM 2.2 in Extendsim
5. Report and Brief Findings – Write final report, brief findings and provide data to SMC/XR

Step 1: Background Information Collection and Review

The first step was to gather and evaluate the applicable DoD and Air Force directives and publications that pertain to the research topic. In addition, related research on the topic was collected and evaluated for inclusion in the model. Fig 6 provides some context on the variety and depth of the policy and directives that space

acquisition program managers must comply with. The documents listed were the primary sources for this step in the research process.

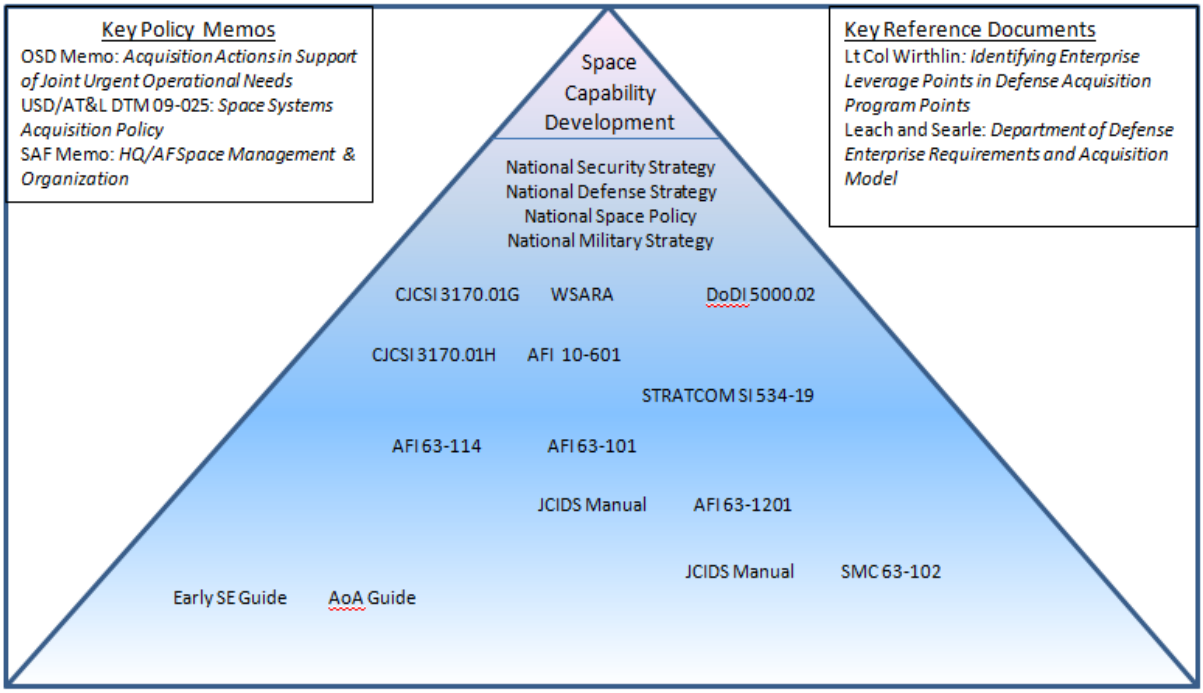


Figure 6: Key Documents for ERAM 2.2

Step 2: ERAM 2.1 Analysis

The next step was to learn how the space acquisition process was modeled in ERAM 2.1. Since it modeled as a discrete event simulation, it was necessary to identify the key points in the model that would need to modified or rebuilt. ERAM 2.1 was modeled in the ExtendSim software package. It utilizes a graphic interface to model processes. There are numerous operations that can be chosen for each icon and the operations parameters are configurable based on what that icon is supposed to represent. Figure 7 is a close up view of the ERAM 2.1 as it was modeled in ExtendSim. It shows a small portion of the model, which actually has over 1000 icons. Leach and

Searle explain some of the more common icons and their operations in ExtendSim very well using the example icons shown in Figure 8 (Leach & Searle, 2011).

"Event/Activity" icon is implemented with a time duration allowing a distribution to be selected. For this research, triangular distributions were implemented based on the data elicited from personnel. The "And Merge With Wait" waits for all the inputs to arrive before proceeding to the next event. The "Or" icon uses Boolean logic to proceed if either of the inputs occur. The "Decision Point" output is based on the likelihood of an event to occur. The probabilities of each event are entered into the properties of the icon.

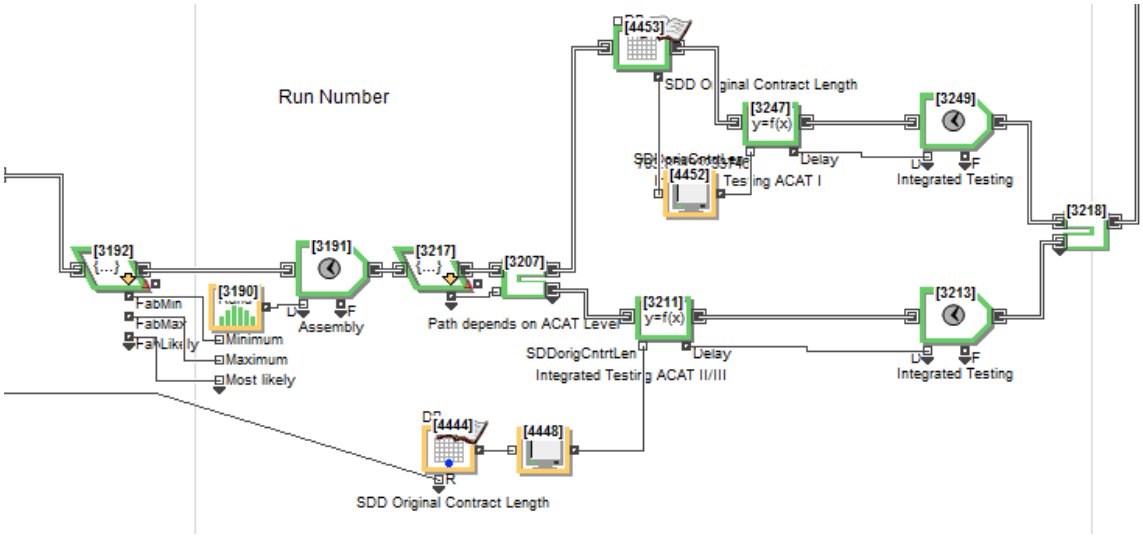


Figure 7: Example ERAM Icon Flow

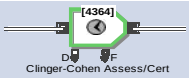
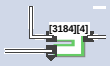
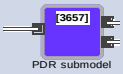
ExtendSim Icon	Function Name
	Event/Activity
	And Merge with Wait
	Or
	Decision Point
	Submodel

Figure 8: ERAM Icons

Step 3: Conduct Interviews

The third step was to conduct interviews with subject matter experts familiar with capability gap analysis, requirements development and the acquisition process. These interviews were scheduled using purposeful and snowball sampling. The interview itself was conducted in a semi-formal manner where the questions were decided ahead of time by the researcher but the conversation was allowed to deviate from the pre-prepared questions. Purposeful sampling identified known SMEs (military, government civilians, Federally Funded Research & Development Contract personnel and support contractors) from SMC, AFSPC, SAF/AQ and other offices involved in space acquisition based on their current or past jobs in the acquisition and requirements fields. The interviews provided a perspective on how and where policy makers and senior leaders are most likely to impact timelines and coordination cycles on required acquisition documentation. All the interviews concluded with a request for

recommendations of additional SMEs hence the use of snowball sampling. A representative list of questions used for the interviews can be found in Appendix II.

The concept of triangulation was utilized to aid in improving results. Triangulation is the concept of approaching the same topic from multiple angles (Neuman, 2006). This was utilized by talking to SMEs at different levels (program office, headquarters, and intermediate headquarters) about the same acquisition programs. By talking to each of them about the same topic, research data was more easily verifiable. Further, existing quantitative data such as documents, policies, actual documented process task durations constituted another approach to verify data.

An interesting issue conducting interviews was the initial lack of willingness by respondents to provide data. Many were willing to talk about their experiences and their opinions on "how the system works" but did not want to share data on their programs. When questioned for their reasoning, all responded that even though the data was not classified, they did not want any programs to be criticized. This response was most evident by the people working at headquarters levels where they had access to information on multiple programs. This concern was mitigated by explaining that all data would be amalgamated into the model with no programs specified. This practice was followed for all results except for the ORS model. Data for only one program was available for this model.

Step 4: Model Processes and Implement updates to develop ERAM 2.2

The next step of the process was to amalgamate all the documents and interviews into the ERAM model. ERAM 2.1 was designed with break points to allow modifications to be made for ACAT II/III programs. In most cases, the process is the same or very similar but the parameters for some of the steps are different. This allowed the researcher to easily work with the SMC/XR and Aerospace teams that are charged with modifying ERAM. Some examples of changes were to the Document Approval Paths. ACAT I programs had a distribution with much larger "Most Likely" and "Maximum" values than ACAT II/III programs so the model had to modified to show this disparity.

Rapid programs were not accounted for in ERAM 2.1. Similarly, after researching the processes currently followed for rapid programs, it was obvious that they are mostly exempt from the processes represented in ERAM 2.1. Due to these facts, a new model had to be built within ERAM 2.2 to represent the two rapid space acquisition processes that data was available for.

Step 5: Report and Brief Findings

The results of the first four steps were compiled and are presented in this research report. A brief synopsis of the main publications that were reviewed on this topic is presented along with the notes from the interviews, information from the policy documents, and an understanding of the ERAM 2.2 model along with comments about the space acquisition business. Finally, the results of the research that were used to modify the ExtendSim code to create ERAM 2.2 from ERAM 2.1 are presented.

IV. Air Force Space Rapid Acquisition

Rapid acquisition has received a lot of attention in recent years as conflicts in Iraq and Afghanistan have created a need to quickly adapt to a group of extremely cunning enemies that have utilized guerrilla warfare techniques. Rapid acquisition is nothing new for the military and has been utilized it for programs such as the U-2 aircraft, the MC-12 aircraft and adding weapons to Predator unmanned reconnaissance aircraft. Essentially the goal is to work outside the normal acquisition process to quickly field a capability that is needed for war. Rapid acquisition is defined by the Department of Defense as:

> a streamlined and tightly integrated iterative approach, acting upon validated urgent or emergent capability requirements, to: conduct analysis and evaluate alternatives and identify preferred solutions; develop and approve acquisition documents; contract using all available statutory and regulatory authorities and waivers and deviations of such, appropriate to the situation; identify and minimize technical development, integration, and manufacturing risks; and rapidly produce and deliver required capabilities. (Department of Defense Joint Chiefs of Staff, 2012)

A more succinct way to define the purpose rapid acquisition was told by Defense Secretary Robert Gates to the media when questioned about the importance of the rapid program, “You have to look outside the normal bureaucratic way of doing things and so does industry – because lives are at stake” (Gates, 2007).

The majority of rapid acquisition is focused on supporting Combatant Commands’ efforts during contingency operations. A recent example that has received a lot of attention is the Mine Resistant Ambush protected (MRAP) vehicles. MRAPs

were quickly developed and procured for U.S forces in response to insurgents using roadside improvised explosive devices (IEDs) in Iraq and Afghanistan. In fact, this became the top acquisition program for 2007 with over 1,500 delivered for over $750M and helped drop the death rate from IEDs by 88% (Vanden Brook, 2008).

Space acquisition programs do not generally fit the profile of rapid programs since development of satellites takes many years and is usually in response to a strategic requirement or predicted tactical shortfall. Air Force Instruction 63-114 titled "Quick Reaction Capability Process" is the primary Air Force guidance for implementing rapid acquisitions. While it is the primary guidance, this research uncovered other organizations that execute rapid space acquisition utilizing other governing guidance. Even though there are many offices within the space acquisition community that can manage rapid programs, many of them are not necessarily in support of contingency operations. Each performs a slightly different mission within the community but they all operate with the promise of delivering a capability faster than the normal acquisition process. Normal acquisition processes are known to take quite a long time or as one program manager stated during an interview "Acquisition programs are not set up to be fast, like Congress with lots of checks and balances." This research discusses the different organizations that are alternatives to the normal acquisition process. The following sections are the result of a compilation of various data sources, including the interviews analyzed according to the previously stated methods.

SMC Rapid Reaction Branch

The SMC Rapid Reaction Branch was created after a 1995 independent review of counterspace programs detailed a need for rapid acquisitions. It is currently located in Colorado Springs. Their mission is to rapidly respond to warfighter requirements by developing new technologies and transitioning them to existing programs. They focus closely on the space superiority mission area with the goal of fielding capabilities between 6 months and 2 years. While much of their work is very sensitive, their process is detailed in Air Force Instruction 63-114 *Quick Reaction Capability Process*. This process was used as the baseline for modeling Air Force rapid space acqusition in ERAM. This process will be detailed later in this chapter.

Air Force Tactical Exploitation of National Capabilities (AF TENCAP)

The AF TENCAP office, along with Army and Navy TENCAP, was established in 1977 with three primary missions: "exploit space systems for tactical applications through rapid prototyping projects; influence the design of future space systems for tactical applications; and educate warfighters about the capabilities and tactical utility of space systems" (Air Force Space Command Public Affairs Office, 2010). Their goal is to act as a bridge between the national intelligence and stategic space communities that operate most space systems and the operational warfighter communities. AF TENCAP demonstrates leading edge space technologies with potential to enhance combat capabilities of units in the field, then transitions these combat systems to warfighters much more rapidly than traditional acquisition processes (Air Force Space Command Public Affairs Office, 2010).

AF TENCAP operates under the premise of bringing prototypes and developmental solutions to the warfighter at the “speed of need”. They work under the acqusition authority of the Program Executive Officer for Space (PEO SPACE), who is currently the SMC Commander. Interviews assed additional detail and context to the understanding of AF TENCAP

AF TENCAP works with a rather small budget($16M) by acquistion program standards but partners with customers that want to benefit from their work. These customers injected over $45M into AF TENCAP programs in 2011.

AF TENCAP accepts projects based on broad operational requirements set by the PEO SPACE, but has two distinct operating principles that differtiate it from other rapid acqusition organizations. First, they constantly survey industry looking for new technologies that could reap rewards by applying them to military problems. Utilizing their own budget or capitalizing on the budget of potential customers, they can plant seed money into these technologies with the hope that it will blossom into a game-changer. Along with these investments into promising technology, they also accept projects that have a defined requirement from a warfighter and manage acquistion programs to meet these requirements. These programs must fit within their charter.

Second, AF TENCAP is allowed to manage their portfolio of projects internally. The commander of AF TENCAP has the ability to direct investment into disciplines and

requirements that will result in the highest reward for their efforts. They accept project based on a basic set of principles[2]:

1. Projects must bear fruit within 18 months.
2. Stay under $1M budget, but will go higher with customer partnership.
3. Maximize Return on Investment (ROI) or Impact of Investment (IOI) of project for the Department of Defense.
4. Manage risk across portfolio to ensure that 75% of projects succeed.

While they are considered a rapid organization, they do not work within the confines of the Air Force Rapid Acquistion regulations but instead are governed by the an Air Force Program Management Directive TEN1(1). While the majority of the ERAM model for rapid space acquistion was based upon the Air Force Rapid Acquistion regulations , the model had to modified to accommodate the latitude that AF TENCAP is given to accomplish their mission. Specifically, the fact that they invest in new technology without a requirement was added to the model.

Operationally Responsive Space(ORS) Office

The ORS office was established in May 2007 in response to National Security Presidential Directive 40 issued in January 2005 calling for an "initial capability for operationally responsive access to and use of space" (USSTRATCOM/J84, 2008). Essentially, the ORS office is charted to try to deliver essential space capabilities to warfighters quickly. Recognizing that this effort would be diffucult under the existing statutes and regulations, Congress specifically stated that "JCIDS would not apply" in the 2007 National Defense Authorization Act (United States Congress, 2006). Along with

[2] This set is very similar to the guiding principles that a small business would operate under, instead of a centrally managed structure that the majority of the AF acquisition community uses.

exemption from the JCIDS process, the ORS office was established with a shortened chain of command. The ORS office is headed by the DoD Executive Agent for Space, who is currently the Deputy Undersecretary of the Air Force for Space Programs.

The ORS office takes on projects with the goal of binning them into three types of solutions:

1. Tier-1 Employment – Capability operational within hours utilizing existing assets
2. Tier-2 Deployment – Capability operational within weeks utilizing field-ready capabilities in storage
3. Tier-3 Development – Capability operational within months after design, assembly and deployment

The ORS Office has undertaken many research projects to build the technology to achieve their objectives but has only been tasked to fulfill four requirements. Three were approved while one was deemed too costly to fulfill. The first was to meet a gap in UHF satellite communciations for the Navy. This was satisfied as a Tier-1 program by purchasing additional bandwidth from commercial communication providers. The second was to meet a gap in space situational awareness which was fulfilled by a Tier-3 development modifying exisiting systems not designed for those requirements. The third program was to meet a gap in intelligence, surveillance and reconnaissance. The ORS-1 satellite program was developed as a Tier-3 program to meet this need. ORS-1 consists of a modified U-2 aircraft camera mated to a satellite bus that had been

developed under another program. It is currently operational in support of US Central Command forces in the Middle East and Afghanistan.

Since the ORS office is exempt from JCIDS, the process that they follow is unique to them and had to be modeled in ERAM seperately from the model based upon Air Force Rapid Acquistion regulations. Combatant Commands can submit requirements to US Strategic Command (USSTRATCOM), which vetts the requirement and submits it to the ORS Executive Committee for approval. Once approved, the ORS office works closely with USSTRATCOM and the requesting Combatant Command to fulfill the requirement.

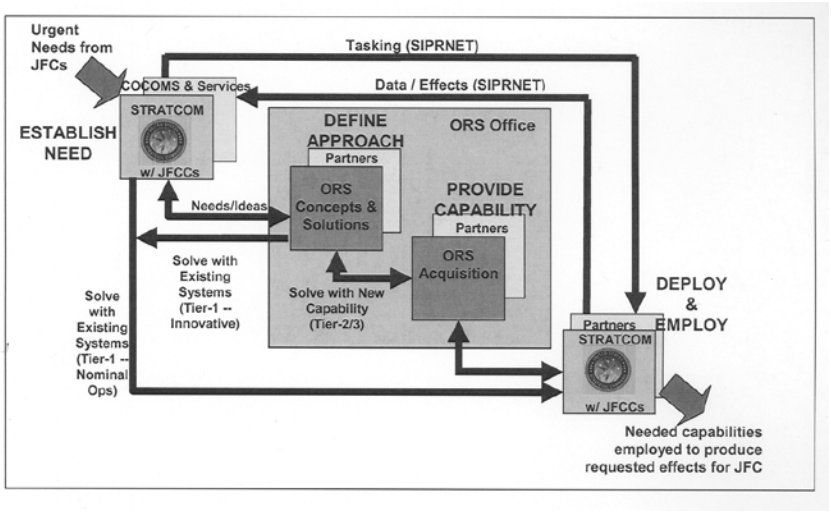


Figure 9: High level ORS Process

(USSTRATCOM/J84, 2008)

The ORS Office is currently being considered for closure in the DoD FY 13 budget based on the idea that it has completed its intial mission requirements. While this is not finalized yet, the intent is for the personnel currently in the program to be distributed throughout the current space acqusition community so they can distribute their knowledge.

USAF Rapid Capabilites Office

The USAF Rapid Capabilities Office(RCO), located in Washington D.C. develops and fields sensitive weapons systems and combat support equipment on accelerated timelines (Air Force Public Affairs, 2012). The majority of the work it performs is classified but it has been revealed that they work on programs such as the X-37B Orbital Test Vehicle, an unmanned, vertical-takeoff, horizontal landing, spaceplane. In order to meet the accelerated timelines that is required for certain programs, the RCO utilizes a streamlined set of processes that are compliant with all statutory guidance but can receive waivers to burdensome processes, procedures and regulations. Further, they tightly integrate with the customer so that the customer is pulling for the capability while the RCO is pushing the product. The RCO was chartered with a very narrow of chain of command for approval. In fact, their streamlined leadership structure is a Board of Directors composed of the Undersecretary of Defense for Acquistion, Technology and Logistics, the Secretary of the Air Force, the Chief of Staff of the Air Force and Assistant Secretary of the Air Force for Acquistion. This is unlike any other Air Force acqusition organization which normally has multiple layers of decision makers of various ranks. The final piece that makes the AF RCO different is that their funding sources are seen as stable. Due to the the fact that all the AF RCO work is extremely sensitive and/or classified, this research did not attempt to include their processes in the ERAM model.

Analysis of Rapid Space Acquisition

After analyzing the different organizations and processes available for acquiring a new capability rapidly, it became obvious that there were essentially three methods available. AFI 63-114 specifies the standard process but AF TENCAP and the ORS Office have variations that are available to them. Budgeting was not modeled for any rapid programs because it usually is the responsibility of the requestor. Without funding available, the requirement is usually not even submitted for consideration.

The process specified in AFI 63-114 and the AF TENCAP process were combined into the block diagram layed out in Fig 10. Statistical distributions for the time to complete the steps in the process were derived based on past programs that entered into the process. Also, there are points within the process where decisionmakers choose which path the process continues down. Each path at the decision points was assigned a probability based on historical data gathered from interviews and documents provided by subject matter experts. Due to the fact that extremely detailed information was not available and/or the complexity of representing the process in ExtendSim, some of the steps are combined into larger steps for the simulation. The combined steps are represented by the gray boxes and they are assigned a box number. Also, they are identified as either duration steps or decision steps. Some steps have different distributions depending on if the acquistion will be completed by TENCAP or by other organizations. The corresponding data that will input into ExtendSim for these steps is shown in Tables 4,5, and 6. The duration data represents the number of days that have

passed since the previous step. The probability data represents the probability that path will be chosen in the model.

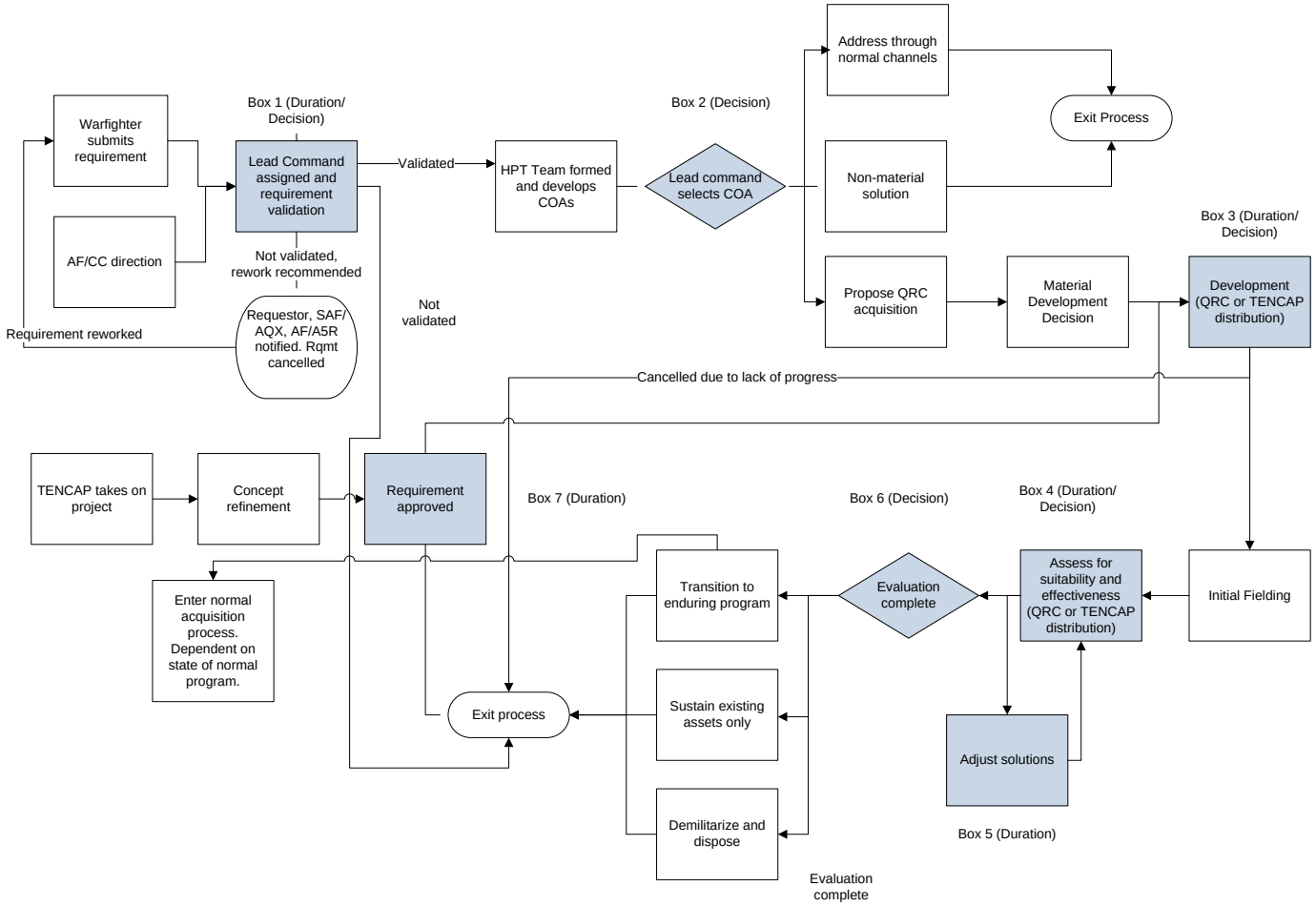


Figure 10: Air Force Rapid Space Acquisition Process

Table 4: QRC Duration Data

		Max (days)	Min (days)	Most Likely (days)
Box 1	Warfighter submits requirement Lead command assigned and requirement Validation	121	1	25
Box 3	Development	360	87	117
Box 4	Assess Suitability	62	11	36.5
Box 5	Adjust solutions	273	10	141.5

Table 5: TENCAP Duration Data

	Requirement	Max (days)	Min (days)	Most Likely (days)
Box 7	Requirement approved	109	1	12
Box 3	Development	317	45	228
Box 4	Assess Suitability	62	2	12
Box 5	Adjust solutions	242	1	43

Table 6: Rapid Program Decision Probabilities

Box 1	Not validated	33.00%
Box 1	Validated	66.67%
Box 2	Propose QRC acquisition	90.00%
Box 2	Non-material solution	5.00%
Box 2	Address through normal channels	5.00%
Box 3	Continue to initial fielding	83.33%
Box 3	Cancelled due to lack of progress	16.67%
Box 4	Evaluation complete	90.00%
Box 4	Adjust solutions	10.00%
Box 6	Sustain existing	20.00%
Box 6	Transition enduring	60.00%
Box 6	Demil/dispose	20.00%

The ORS Office has a significantly different process than other rapid acquisition organizations. They are exempt from JCIDS and USSTRATCOM acts as the gatekeeper for all requirements. The ORS Executive Committee determines if a requirement should be assigned to the ORS office and also procures funding. The ORS process was modeled separately in ERAM and is represented by the block diagram in Fig 11. The durations for steps and probabilities of decisions are shown in Tables 7 and 8. Due to the fact that this process was only exercised four times and only produced one acquisition program

(ORS-1), it is very likely that the model may not be very accurate as a predictive tool for future programs. As an example, process step durations are not represented by a triangular distribution because there is not enough data available to build a distribution.

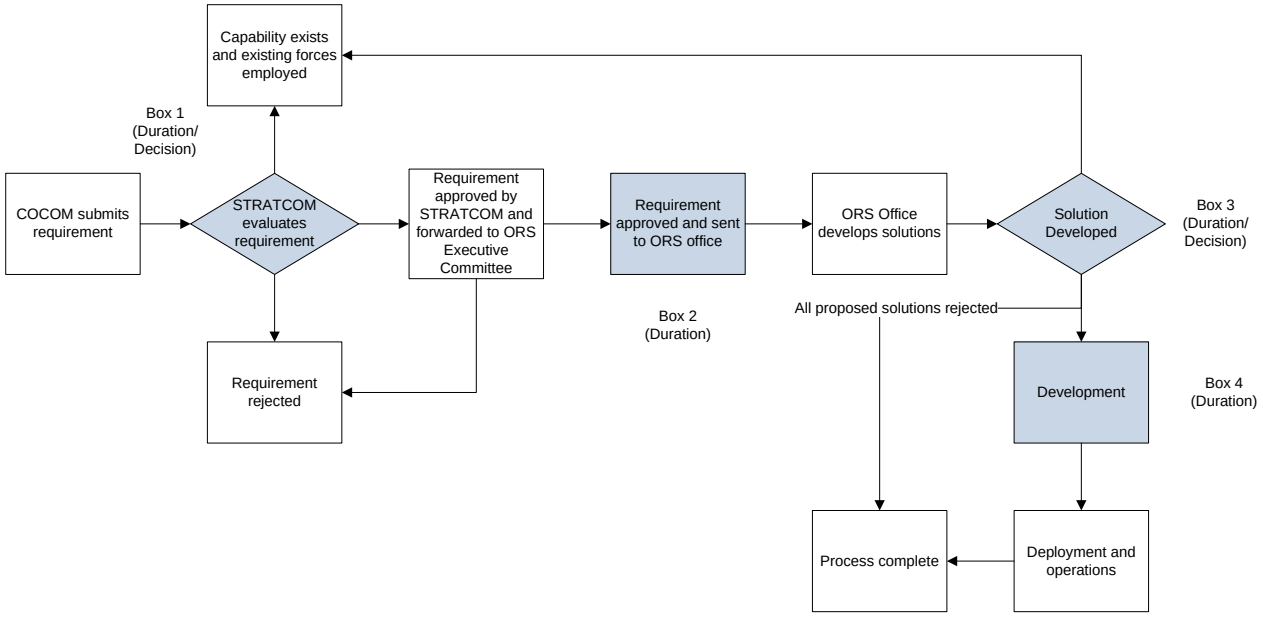


Figure 11: ORS Process

Table 7: ORS Duration Data

		Duration (days)
	COCOM submits requirement	
Box 1	USSTRATCOM evaluates requirement	61
Box 2	Requirement approved by Exec Committee	153
Box 3	Solution developed	243
Box 4	Development	730

Table 8: ORS Decision Probabilities

Box 1	STRATCOM determines capability already exists	25%
Box 1	Requirement approved	75%
Box 3	Development	33%

Box 3	ORS office proposes existing capability	33%
Box 3	ORS proposed solutions rejected	33%

V. Air Force ACAT II/III Acquisition

Differences between ACAT I and ACAT II/III

The major discriminator between managing an ACAT I program and ACAT II/III programs is the rank/position of the Milestone Decision Authority (MDA). The MDA is the designated individual with overall responsibility for a program that has the authority to approve entry of a program into the next phase of the acquisition process(USD(AT&L), 2007). For almost all Air Force space programs, the SMC Commander is appointed as the PEO but MDA authority is only delegated to them for ACAT II/III programs. The Under Secretary of Defense for Acquisition, Technology, and Logistics (USD(AT&L) retains MDA authority over all ACAT I programs. This essentially means that all major decisions and documents for ACAT I programs must pass through another level of review, creating more steps in the process and obviously taking more time. This fact was the primary driver for most modifications to ERAM 2.1 to create ERAM 2.2.

The difference in cost of the different ACAT levels also drives a major difference in how programs are now managed. In the past, space ACAT I programs were given all the attention because as one HQ/AF expert noted, “we try to make every satellite into a Battlestar Galactica.” He then went on to explain that high launch costs cause planners to try to get as much capability on-orbit with each satellite. Essentially, since a launch was a fixed cost, the expectation was to maximize the capability per launch. When this

concept was presented to an AFSPC capability planner a during research interview, she emphasized that this paradigm has primarily ended. Due to recent and looming funding cutbacks, AFSPC is now focused on "keeping requirements at a basic level and then performing block upgrades." She noted that they are trying to keep programs at the ACAT II or lower level to ensure funding is available. This paradigm shift shaped the results for ERAM 2.2 because there are multiple steps within the process where funding needs to be procured. SMEs noted that the timelines to gather funds for smaller programs was much shorter.

Another of the major differences between ACAT I programs and ACAT II/III programs is the reporting requirement. US Code Sec 2432 requires that all Major Defense Acquisition Programs (MDAP) submit status reports on the program for Congressional review. These reports are known as Selected Acquisition Reports (SAR) and are required to be submitted quarterly. They summarize the latest estimates of cost, schedule and performance status for the program and identify deviations from past reports. The requirements to be considered an MDAP are more stringent than ACAT I programs but essentially are the same. The current SMC ACAT I portfolio consists of 17 programs and 14 of them are currently considered MDAPs but no ACAT II/III programs are MDAPs (USD (AT&L), 2010).

The fact that SARs are optional but not required for ACAT II/III programs presented a major problem in gathering quantitative data for this research objective. When asked about this requirement, one program manager noted; "SARs are optional but our PEO doesn't want them so we don't do them." None of the five program

managers interviewed had ever seen a SAR completed for anything but an ACAT I program. In addition to SARs, Monthly Acquisition Reports are required for all Air Force acquisition programs. For unclassified programs, these reports are uploaded to a database called System Metric and Reporting Tool (SMART). SMART is a collaborative web-based application designed to assist program managers and acquisition leaders with reporting and viewing program health and status(Defense Acquisition University, 2009). While SMART has a wealth of data, it only has data back to 2010. In addition, ACAT II/III programs were only required to file MARs in SMART starting in April 2012.

With no central repository for ACAT II/III data, interviews and documents provided by the SMEs had to serve as the primary sources of data for modifying ERAM 2.1 to ERAM 2.2. In many cases, the respondents could not provide exact data but instead provided "rules of thumb" based on their experiences. Meyer and Booker identify this type of data gathering as very useful when trying "to provide estimates on new, rare, complex, or otherwise poorly understood phenomena" (Meyer, 2001). The goals of this research fit these criteria very well. The positive aspects of this type of data for the model is that it is based upon experts in their field that have years of experience in their positions. The negative aspects are that it is possible that "some people "rewrite" the past to make it more consistent with current beliefs or remember the past in a self-enhancing way" (Neuman, 2006). With these cautions and caveats noted, the following analysis was done.

Analysis of ACAT II/III Programs

After consulting with experts at SMC, AFSPC and Headquarters Air Force, ERAM 2.1 was reviewed based on their feedback. Points in the model were identified that needed to be modified to accommodate variations in ACAT level. Changes to the model were dependent on four factors.

1. MDA for ACAT I programs is USD(AT&L) which drives extra preparation and reviews for these programs. MDA for ACAT II/III programs is SMC/CC so preparation time and the number of reviews are reduced.
2. ACAT II/III programs are less costly so contracts and documents are usually shorter.
3. ACAT II/III programs are less costly so the time to gather funds is reduced in most cases.
4. Testing duration is normally reduced for ACAT II/III programs since the program is not as complicated. ACAT I programs usually have many more requirements and, therefore, more test objectives.

These factors were based on policy documents such as DoDI 5000.02 and the SMC Acquisition Development Strategy Guide as well as the feedback provided by SMEs at SMC, AFSPC headquarters and SAF/AQ. The following sections detail the steps in the ERAM model that were identified as needing medication based on ACAT level.

Prior to Milestone A:in ERAM

Table 9: Modified Duration Data for ERAM Steps Prior to MS-A

Step Name	Distributions by ACAT Level								
	I			II			III		
	Min	Max	Most Likely	Min	Max	Most Likely	Min	Max	Most Likely
Prepare for Acquisition Panels	40	60	56	15	60	35	15	45	25
Check for Funding	30	270	120	30	360	60	15	360	60
Draft RFP Prep	20	40	34	10	20	17	10	20	17
RFP Coordination Process	50	1200	370	55	297	165	55	297	165
Prep w/ PEO	15	35	30	N/A	N/A	N/A	N/A	N/A	N/A

The differences in each step are explained below:

Prepare for Acquisition Panels – Program managers noted that preparation time was weeks longer for ACAT I programs. More organizations were required to review all documents and they each provided feedback in preparation for the acquisition panels.

Check for Funding – Many times a program will need to compete for funding against other needs. Due to budget cuts, it is easier to procure funding for smaller programs now.

Draft RFP Prep – Data provided by SMC acquisition officials showed that Request for Proposal (RFP) for ACAT I programs took twice as long as smaller programs. They may be much longer documents or have more requirements.

RFP Coordination Process – More organizations want to see the RFP for ACAT I programs than ACAT II/III programs driving a longer timeline

Prepare with PEO – ACAT I programs require additional meetings with the PEO and staff to prepare for MDA meetings.

Prior to Milestone B in ERAM

Table 10: Modified Duration Data for ERAM Steps Prior to MS-B

Name	Distributions by ACAT Level								
	I			II			III		
	Min	Max	Most Likely	Min	Max	Most Likely	Min	Max	Most Likely
Contract Length	365	2190	1980	365	2190	1095	365	2190	550
Prepare for Acquisition Panels	40	60	56	15	60	35	15	45	25
Prep w/ PEO	15	35	30	N/A	N/A	N/A	N/A	N/A	N/A
Independent cost estimate	30	60	35	N/A	N/A	N/A	N/A	N/A	N/A
Acquisition Planning	60	1200	300	60	330	210	60	330	210
Developmental Testing	Testing length(TL) for ACAT I is 25% of Contract Length. Testing length(TL) for ACAT II/III is 15% of Contract Length. Min=75% of testing length Max==1.1% of testing length Most Likely=testing length								
Funding required	90	270	225	30	270	90	30	270	90
Start of Test & Evaluation	If ACAT I, has 75% of contract elapsed, otherwise if ACAT II/III has 85% of contract elapsed.								
PEM/Other Staff find money	14	270	83	5	270	160	5	270	160

The differences in each step are explained below:

Contract Length – ACAT I programs normally have a much longer contract due to the size, cost and complexity of these programs

Prepare for Acquisition Panels – Program managers noted that preparation time was weeks longer for ACAT I programs. More organizations were required to review all documents and they each provided feedback in preparation for the acquisition panels.

Prepare with PEO - ACAT I programs require additional meetings with the PEO and staff to prepare for MDA meetings.

Independent Cost Estimate –The Weapons System Acquisition Reform Act of 2009 requires independent cost estimates for all MDAP programs, and therefore almost all ACAT I programs. Air Force Cost Analysis Agency SMEs noted that independent cost estimates are optional but never completed for ACAT II/III programs.

Acquisition Planning - Data provided by SMC acquisition officials showed that acquisition strategy planning follows the same process regardless of ACAT level but usually takes longer for ACAT I programs.

Developmental Testing – Program managers noted that the amount of testing is usually based on contract length. The way this data is derived is that ERAM will first pick a contract length using the Monte Carlo simulation. It will then calculate a testing length (TL) and then scaling factors are applied to create a triangular distribution based on this TL.

Funding required - Many times a program will need to compete for funding against other needs. Due to budget cuts, it is easier to procure funding for smaller programs now.

Start of Test and Evaluation(T&E) – ERAM 2.1 was built to not start T&E until a certain percentage of the acquisition contract had elapsed. SMEs identified that this percentage is slightly different for ACAT II/III programs.

PEM/Other Staff find money - Many times a program will need to compete for funding against other needs. Due to budget cuts, it is easier to procure funding for smaller programs now at this point in an acquisition program, ACAT I programs are usually "too big to fail" so funding is easier to acquire.

Prior to Milestone C in ERAM

Table 11: Modified Duration Data for ERAM Steps Prior to MS-C

Name	Distributions by ACAT Level								
	I			II			III		
	Min	Max	Most Likely	Min	Max	Most Likely	Min	Max	Most Likely
Contract Length	365	2190	1980	365	2190	1095	365	2190	550
Integrated Testing	Testing length(TL) for ACAT I is 25% of Contract Length. Testing length(TL) for ACAT II/III is 15% of Contract Length. Min = 75% of TL Max = 1.1% of TL Most Likely = TL								
Develop System & Live Fire Test & Operational Readiness Test	Testing length(TL) for ACAT I is 7% of Contract Length. Testing length(TL) for ACAT II/III is 5% of Contract Length. Min = 75% of TL Max = 1.1% of TL Most Likely = TL								
Acquisition Planning	60	1200	300	60	330	210	60	330	210
Funding Required	90	270	225	30	270	90	30	270	90
Prepare for Acquisition Panels	40	60	56	15	60	35	15	45	25
Prep w/ PEO	15	35	30	N/A	N/A	N/A	N/A	N/A	N/A
Program Review	25	35	30	25	35	30	25	35	30
PEM/Other Staff find Money	14	270	83	5	270	50	5	270	30

The differences in each step are explained below

Contract Length – ACAT I programs normally have a much longer contract due to the size, cost and complexity of these programs

Integrated Testing – As noted under Developmental Testing in the previous section, program managers indicated that the amount of testing is usually based on contract length. The way this data is derived is that ERAM will first pick a contract length using a Monte Carlo simulation. It will then calculate a testing length (TL) and then scaling factors are applied to create a triangular distribution based on this TL. This case is for combined developmental and operational testing.

Develop System & Live Fire Test and Operational Readiness Test – If a separate live fire and operational test is conducted it is also usually a percentage of contract length but slightly shorter for ACAT II/III program. See explanation under Integrated testing.

Acquisition Planning - Data provided by SMC acquisition officials showed that acquisition strategy planning follows the same process regardless of ACAT level but usually takes longer for ACAT I programs.

Funding required - Many times a program will need to compete for funding against other needs. Due to budget cuts, it is easier to procure funding for smaller programs now.

Prepare for Acquisition Panels – Program managers noted that preparation time was weeks longer for ACAT I programs. More organizations were required to review all documents and they each provided feedback in preparation for the acquisition panels.

Prepare with PEO - ACAT I programs require additional meetings with the PEO and staff to prepare for MDA meetings.

PEM/Other Staff find money - Many times a program will need to compete for funding against other needs. Due to budget cuts, it is easier to procure funding for smaller programs now at this point in an acquisition program, ACAT I programs are usually “too big to fail” so funding is easier to acquire.

VI. Conclusions

Tools such as ERAM 2.2 are geared to help acquisition planners improve their skills and provide early schedule estimates based upon existing statutes, policy and most importantly historical data. Improvements in this area are necessary because the "average total cost growth factor for completed Major Defense Acquisition Programs (MDAPs) was 46 percent" (Younossi, 2008). While this data includes programs from all services, this research has shown that space programs are not any different.

ERAM 2.2 can help SMC acquistion planners better map out programs in the intial stages of development. While they previosuly only had the ability to look at ACAT I programs, this version now allows the model to be fine-tuned for all ACAT levels as well as different types of rapid programs.

While tools such as ERAM are useful, it is obvious that it will not affect programs unless the lessons learned are applied to acquistion programs. A recent article points to a "conspiracy of optimism" where military planners want to obtain a capability they cannot afford, or which is at the risky end of the spectrum. To avoid scaring those assessing or paying the bills, they either under-estimate how much it will cost, or they fudge the risk of the project, or both (Sweetman, 2012). If this type of behavior is true, then it does not matter how many good tools are developed because their recommendations will be ignored.

Areas of Further Research

ERAM 2.2 is an improvement to ERAM 2.1 but it is definitely not a complete product. This research utilized analysis of existing policy and guidance, interviews with SMEs and acquisition program documentation provided by the SMEs. Even though ERAM 2.2 will be useful for SMC planners, listed below are additional topics that can be explored to improve the model or utilize it in different ways.

1. Air Staff acquisition policy SMEs noted that Congress signs into law over 1000 changes that affect the DoD annually. It usually takes 2-3 years for the appropriate documents to be modified and distributed to program managers and planners. Due to these constant changes, ERAM can never remain a static tool if it is to remain useful. Annual maintenance will be required to keep it up to date with new policy and to also ensure that representative data sets are current.
2. Leach and Searle pointed out the ERAM could be the "backbone of a training program"(Leach & Searle, 2011). SMC/XR recommended to Defense Acquisition University that they learn more about ERAM with the intent that they can use it to train DoD and industry PMs.
3. ERAM could be tailored to any kind of acquisition program, not just space. Other types of acquisition programs such as information systems, aircraft or naval systems could benefit from a version of ERAM modified to fit their process.
4. Many parts of this model are still incomplete or based on a small data set. Further research is definitely needed to fill in the gaps that were found in

when looking at the work of organizations such as AF TENCAP, ORS Office and AF RCO.

Appendix I –Rapid Acquisition Program Raw Data

Table 12: JUON Data

	Program 1		**Program 2**		**Program 3**	
Warfighter submits requirement	6-Jun-10	Days	12-Aug-11	Days	12-Oct-07	Days
Validation	17-Sep-10	103	6-Sep-11	25	28-Oct-07	16
MDD			24-Feb-12			
Initial Fielding	13-Dec-10	87	31-Aug-12	360		
Assess Suitability	13-Feb-11	62				
Adjust solutions	13-Nov-11	273				
Final disposition	TBD		TBD		Rejected JRAC	

	Program 4		**Program 5**		**Program 6**	
Warfighter submits requirement	8-Jun-06	Days	25-Aug-06	Days	28-Jun-06	Days
Validation	30-Jun-06	22	13-Sep-06	19	27-Oct-06	121
MDD						
Initial Fielding					1-Mar-07	125
Assess Suitability						
Adjust solutions						
Final disposition	Rejected JRAC		Rejected JRAC		Sustain existing	

	Program 7		**Program 8**		**Program 9**	
Warfighter submits requirement	2-Jun-11	Days	10-May-07	Days	15-Jul-09	Days
Validation	30-Jun-11	28	12-Jun-07	33	16-Jul-09	1
MDD			11-Sep-07			

Initial Fielding	17-Oct-11	109				
Assess Suitability	28-Oct-11	11				
Adjust solutions	7-Nov-11	10				
Final disposition	Demilitarize/dispose		Transition enduring		Rescinded 10 Jul 10	

Table 13: TENCAP Data

	TC #1		TC #2		TC #3	
Requirement	4/25/2011	Days	2/5/2010	Days	1/1/2010	Days
Development start	7/5/2011	71	2/15/2010	10	1/2/2010	1
Development complete	2/10/2012	220	12/15/2010	303	11/15/2010	317
Transition to user	2/15/2012	5	2/15/2011	62	1/10/2011	56
Project complete	2/16/2012	1	10/15/2011	242	5/15/2011	125

	TC #4		TC #5		TC #6		TC #7	
Requirement	1/1/2011	Days	12/1/2009	Days	8/16/2011	Days	3/3/2010	Days
Development start	2/15/2011	45	3/20/2010	109	8/20/2011	4	3/15/2010	12
Development complete	10/1/2011	228	8/20/2010	153	6/15/2012	300	4/29/2010	45
Transition to user	10/3/2011	2	9/1/2010	12	6/22/2012	7	5/16/2010	17
Project complete	11/11/2011	39	10/14/2010	43	6/29/2012	7	7/15/2010	60

Table 14: ORS Data

	ORS-1	
Requirement	3/1/2008	Days
STRATCOM approval	5/1/2008	61
Executive committee approval	10/1/2008	153
Solution chosen	6/1/2009	243
Deployment	6/1/2011	730

Appendix II – Sample Interview Questions

1. Describe your roles and responsibilities in the space acquisition processes.

2. What space programs do you have experience with?

3. Describe what processes you've been involved with regards to space capability development (i.e. gap analysis, S&T, JCIDS documents, DP, and/or acquisitions) and with which program. What level was the program?

4. Describe the specific activities and decision points for the processes you've been involved in from question 3.

5. What do you see as the primary differences between ACAT I/II/III programs? Were there specific activities that were different?

6. What reviews and documentation were required for your program?

7. Describe the role, if any, you had with rapid programs.

8. What was the timeframe for approval on the required documentation? Which organizations were required for coordination? What obstacles needed to be overcome?

9. Have you experienced delays with your programs? If so, what would you say was the primary driver of that delay?

10. When did the various reviews and other meetings occur in your program? Who was required to attend? What were the challenges that arose? How did you overcome those challenges?

11. If applicable, what waivers were applicable for moving your program forward? How did you obtain approval for those waivers?

12. Would you be willing to provide data on the durations of the activities and probabilities for decision points?

13. Is there anyone specific that you recommend I talk to about these topics?

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14. ABSTRACT

Air Force senior leadership has continued to emphasize the need for progress on improving cost and schedule estimates for military acquisition programs. The Enterprise Requirements and Acquisition Model (ERAM) as modified by Leach and Searle is a quantitative discrete-event process simulation model accounting for activities from early capability analysis through system fielding of ACAT I space acquisition programs. This research seeks to modify the existing model by including ACAT II/III programs along with modeling the Rapid Acquisition process for space programs using the same methodology and techniques. The model begins with identification of a desired space capability early in the Joint Capabilities and Integration Development System (JCIDS) process through system development at Milestone-C (MS-C) of the acquisition system resulting in a probabilistic schedule distribution for a given concept. The research focused on identifying activities and assigning duration distributions and probabilities based upon past programs at each decision point. Data was collected through analysis of applicable policy, instructions, and journal articles as well as interviews with subject matter experts (SME) from the Air Staff, AFSPC and the Space and Missile Systems Center (SMC). ERAM has been utilized at SMC's space Concept Design Center (CDC) providing program managers insight into program duration estimations and probabilities of program success for concepts based on historical comparisons. Defense Acquisition University has also found interest in ERAM to be used as a training tool for personnel to better understand required procedures needed to acquire a space capability on schedule and within budget.

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